# Appendix J - Meeting reports and mails

## Introduction

This appendix describes the different meetings and covers meeting reports of meetings conducted throughout the thesis period. The last section of the appendix also contains important mail correspondence.

## Meetings with supervisor at NTNU

Regular meetings involving the students and their local supervisor at the university were carried out every week throughout the thesis period. The objectives and intentions of the meetings were as follows:

- Discuss the process and status of the thesis.
- Discuss the students work
- If necessary, the supervisor provided the students with technical guidance or helpful advice.
- If necessary, the supervisor to provided instructions and important information regarding the structure of the bachelor thesis subject.

This was the main discussion areas and objectives at these meetings, with an duration of typically a half to one hour. A decision was made to not write meetings reports of these meetings, as the objectives were the same and the time could be spent on more valuable work.

## Meetings with Aker Solutions

This section covers all the meeting reports of meetings conducted with Aker Solutions. The meetings involved the two students and personnel in Aker Solutions. Who participated from Aker solutions dependent on the meetings objectives and available personnel at the relevant department. The next page covers a table which present an overview of the meeting reports.

*Note: Both the students participated at every meeting and are therefore not mentioned at the participant list.*

**Temporal record of meetings**

| No. | Date | Location | **Title** and purpose | Particpants |
|---|---|---|---|---|
| 1 | 17.12.18 | Tranby | **Briefing.** Discuss the thesis. Get to known each other. | Sverre Olsen<br>Daniel Skogen<br>Dag Snildal |
| 2 | 09.01.19 | Tranby | **Meeting with supervisors.** Discuss the thesis and consider any modification to it. | Sverre Olsen<br>Daniel Skogen |
| 3 | 10.01.19 | Tranby | **Meeting with "Senior product specialist".** Discuss the thesis and questions from the students | Lars Lundheim |
| 4 | 10.01.19 | Tranby | **Meeting with "Product engineer".** Discuss the thesis and questions from the students | Dag Snildal |
| 5 | 11.01.19 | Tranby | **Meeting with "Manufacturing engineer" in the workshop**. Get the point of view from an industrial mechanic. | Goran Adzic |
| 6 | 11.01.19 | Tranby | **Meeting with the supervisors.** Discuss the thesis. | Sverre Olsen<br>Daniel Skogen |
| 7 | 23.01.19 | Skype | **Meeting with "Senior project engineer".** Get a better understanding of the different lifting scenarios. | Caroline Gulliksen |
| 8 | 07.02.19 | Skype | **Status meeting with supervisor.** | Sverre Olsen |
| 9 | 09.02.19 | Skype | **Meeting with "Specialist engineer".** Get guidance and information regarding the design basis. | Ivars Grisans |
| 10 | 28.02.19 | Skype | **Concept design review.** Perform detailed and thorough review of the concepts, with intention to do a concept selection. | See report. |
| 11 | 01.03.19 | Skype | **Meeting with supervisor.** Discuss the concept design review. | Sverre Olsen |
| 12 | 01.03.19 | Skype | **Meeting with "Specialist engineer".** Discuss his concepts drawings. | Ivars Grisans |
| 13 | 12.03.19 | Skype | **Secondary concept design review.** Perform a detailed and thorough review of our chosen concept. | See report |
| 14 | 13.03.19 | Skype | **Meeting with supervisor.** Discuss the secondary concept design review. | Sverre Olsen |
| 15 | 29.03.19 | Skype | **Meeting with "Global riser analysis engineer".** Get some tips and assistance in FEA and methodology at Aker Solutions. | Jon Elfridsson |
| 16 | 29.03.19 | Skype | **Status meeting with supervisor.** | Sverre Olsen |
| 17 | 15.04.19 | Skype | **Status meeting with supervisor.** | Sverre Olsen |

# Meeting no. 1 - Briefing

**Location:** Tranby **Date:** 17.12.2018

**Purpose:** Discuss the thesis. Get to known each other.

Our first meeting with Aker Solutions was at their facility in Tranby. We got a tour at the facility where we were able to see what equipment we would modify. We went through the task and got to know what they expect from us and overall clarity about the task.

**Themes and questions**

- Planning
  - First to be done. Finished in one day.
  - Percentage overview of worktime at the different phases/tasks
  - Schedule and dates for meetings, presentations for class and Aker, Business case, concept selection etc.
- Lifting Scenarios
  All lifting scenarios of the TRT and Lifting and handling tool should be considered:
  - With FCM (flow control module)
  - Both FCM and SCM mounted at XT
  - Lifting XT only
  - Workshop → Trailer → Vessel → Rig → Subsea → Maintenance.
  - They stated that the lift between the vessel and the rig was a critical lift due to the weak and unstable crane on the vessel.
- Timesheet. Work hours to be registered during the semester. Excel. Log
- Different limitations for the tools:
  - Height in workshop
  - Off center lifting in moonpool.
- Tip: Gather all relevant mail discussions in folder. Historical. Change name.
- NTNU mal in report is fine.
- Possibility to use buoyancy at TRT?
- Keep all Aker Solutions related documentation and files at Aker PC. Before presentation for class or other type of sharing Aker's ownership, Sverre or Daniel has to approve.

## Meeting no. 2 - Meeting with supervisors.

**Location:** Tranby **Date:** 09.01.2019

**Purpose:** Discuss the thesis and consider any modification to it.

Some modifications and comments regarding the thesis were noted, which the following list describes:

- Point two - Business case - They wanted us to have a very simple estimation of costs with focus on kg/xt, NOK/kg and savings for a typical project.
- Point four - Concept and concept selection - They said that we did not need to do FEA as long as we had some kind of calculation. But the studens agreed that they would have it anyway. Small edit in the text.
- Agreed with only one business case and not two.
- A small edit to the last section was also done. This became the final edition and was sent to supervisor at NTNU.

**Other notes**

- IHS.akersolutions.com can be used for finding documentation.

## Meeting no. 3 - Meeting with "Senior product specialist".

**Location:** Tranby **Date:** 10.01.2019

**Purpose:** Discuss the thesis and questions from the students.

The following list covers important notes and comments that was noted during the meeting.

- He suggested that we take contact with Caroline Gullikson since she has full control off lifting/transport and all the regulations that apply. Design manuals.
- Most critical lift is from vessel to rig.
- He encouraged us to draw boxes of every lifting scenario and write down limitations and solutions. Block diagram.
- Internally on a rig there is at least one crane. One crane is over the moonpool and the other cranes is often lighter and does not have heavy specs. You should have the possibility to lift with the small crane. When the XT is on the rig it slides over a bridge crossing the moonpool. Then XT is lifted and the bridge slides away.
- Curser system/guide wire is used when lifting in the moonpool. Max dimensions in a moonpool is 4.8m x 4.8m. There is a height limitation at the moonpool, the cursor itself has a height that we need to consider. The moonpool crane can PROBABLY slide XY directions in some way, which means that an off center lift is possible. We need to check that out.
- The benefits of a lighter lift is bigger weather window, maybe smaller boat/vessel and less damage if it crashes. Contact person regarding FEA: Jonas Åkerlund.
- What about failure? We need to consider what happens if we have a two or more point lift and one of the wires break/snaps. Or what if the tool fails?
- One solution is to change the tool on main land and not on the vessel/rig. In other words, change from handling tool to TRT at the dock. But that is another problem if the vessel has more than one XT onboard. The vessel has maximum four XT. In this case, four tools would be necessary.
- Make something fool proof. Pre-defined locks in each direction. What if the operators put the OFF-CENTER hook in the wrong hole? Double security.
- Typical moonpool crane limit is 50t, but it is more convenient to lift 40t.
- Documents on regarding maximum allowed angel: API 6A/ ISO10423 and API17D/ ISO13628/4.
- The companies wants to use the whole weather window. Thereby, lighter is better.
- When offshore, no one will climb on top of the XT and mount a tool (TRT and LTRT). This has to be automated in some way. Snagging is something to consider when transporting a XT and lifting it in the moonpool. Anything outside the XTs footprint is in the “snagzone”.
- Calculations at the H4 profile is not necessary.
- We can not use space outside the XT’s framework when designing the tool.

## Meeting no. 4 - Meeting with "Product engineer"

**Location:** Tranby **Date:** 10.01.2019

**Purpose:** Discuss the thesis and questions from the students.

The following list covers important notes and comments that was noted during the meeting.

- Had some discussions regarding the LTRT and IVTC-RT tool (runs internal tree cap and XT), were the intention was that we could use some of the concepts where in our design.
  An important reminder from that discussion is that in many of our early solutions we would have a load situation where horizontal forces and moments would be generated to the H4 connection. There are few calculations of such horizontal forces acting on H4 connectors, because Akers connectors only experience one vertical force to the connector.
  Ravi Abbigeri will follow us up when we have done some calculations on this. The plate in the LTRT is also sensitive/loose and are not made to experience forces acting downwards or moments.
- Our concept where the lifting tool have different holes to attach the shackle to ("Santa hat" or caps), we can have small weights on the opposite side of the tool to make the lift 100% level.
- Calculation report in SAP to find material data and calculations.
- Lifting tool maximum weight is 15 ton on vessel or rig (Equinor).
- Different standards:
  - DNV GL 273 2-7/3 - Standard for lifting tools offshore
  - DNV GL 273 2-7/1 - Standard which describes pad-eye calculations (Appendix D)
  - NORSOK R002 - Lighter version of 2-7/3
- Material number LTRT: 10038167.
- COG of the XT is settled late in the assembly.

## Meeting no. 5 - Meeting with "Manufacturing engineer" in the workshop"

**Location:** Tranby **Date:** 11.01.2019

**Purpose:** Get the point of view from an industrial mechanic.

The following list covers some questions the students prepared and answers regarding them.

- **Height limit in workshop?**
  In the tightest areas, like into test pits, maximum tool height would be 2m.
- Is the XT lifted with TRT in the workshop?
  No.
- **Is there any variation on the COG and have you experienced large COG offset/XT tilt?**
  They have experienced a shifting COG even tho all the trees are supposed to be identical. They then have to experiment with different weights to hit the goal of maximum 1.7 degrees. The max difference they have experienced is 600kg difference in counter weights on the same type of trees.
- **Considering to enter the spool and the H4 profile, how crucial is it to lift the tool in a level position?**
  Maximum angle on the tool on the H4 profile depends on the specification of the operation. But its typical 0.5 to 1.5 degrees.
- **What is advantages with today's tool?**
  One lifting points instead of several points
- **Disadvantages with today's tool?**
  You have to climb on top of the TX and mount it. That means the need for fall protection equipment and it is time consuming.
- **What could have made the operations easier?**
  - Something that keeps the shackle in a "upright" position which makes it easy to hook it on/off without. It works great on the VXT HT 10169376 which is used at the Kaombo project.
  - Quick lock bolt 1021500. Cross-By.
  - A way to lock/unlock on the H4 profile when standing on the floor and not climb on top of the XT.
- **How many times is counterweights assembled/disassembled during fabrication of the XT?**
  One time. They put the frame in place and build everything on that frame in that position.
- **What do you mean is the most important to have in mind when designing the new tool?**
  Easy to use. Use locking dogs and an easy locking mechanism.

- **What is the weight limitation the workshop?**
  There is several cranes inside the workshop. The biggest one has a capacity of 100t, but that is just in one part of the factory. In another place, the max capacity is 70t. That is why 70t is the limiting factor in the workshop.
- **What kind of maintenance do you do at today's handling tools?**
  - HXT XTHT - Inspection of locking ring. Measuring of correct diameter.
  - VXT XTHT - Only visual check on locking dogs.
- **Total number of lifts in the workshop at each XT produced?**
  Five to six times due to a lot of testing. Only one time during assembly.
- **Why a big handle for the locking ring? And why so heavy? Referring to 10169376.**
  Easy to use, but can be made smaller. Handles can probably be made in aluminium and not steel.

**Other notes**

- The heaviest XT in the workshop is at 70 tonnes. But they are aiming for lighter XT. Anyhow, tool requirements on today's tool are at 70 tonnes.
- Some relevant material numbers:
  - VXT XTHT with test eq.: 10169318
  - VXT XTHT: 10169376
  - Standard XTHT for HXT/H4 profile: 1014224
- During subsea XT installation, The total allowed angel is at 1°on the wellhead and 1.5°on the XT. Combined to 2.5°.
- Every Kaombo VXT was equipped with a XTHT when they were shipped from Tranby to Africa.
- Locking dogs is preferred instead of locking ring. Additional to inspection requirement, the locking ring has the following failure modes:
  - If the ring is worn, there could be a danger of partly attachment to H4 profile even if it should be released. Such a case could result of snagging in the connection during lift of, which could result in damage to people nearby or the equipment.
  - There is a total of eight bolts that compress the ring. One or more could be forgotten.

## Meeting no. 6 - Meeting with "Manufacturing engineer" in the workshop"

**Location:** Tranby **Date:** 11.01.2019

**Purpose:** Discuss the thesis.

The following list covers important notes and comments that was noted during the meeting.

- Regarding the business case, the price in the PO (Purchase Order) is price per counterweight. It is important that we check how many counterweights it is per XT, as the amount in the PO does not reflect this! Check the amount of counterweights/XT by following the BOM (Bill Of Material), but do not start in a high level. If you start too high, SAP (Aker Solutions document database) will count the amount of XT in the project and multiple with CW/XT. So find the XT material number and start the BOM from this level.
- Important to include in the design basis:
    - The design of the tool should only be to a H4 18-3/4 ” interface. An handling tool to a VXT re-entry hub does not need to be designed
    - Use the list of XT’s we got from Daniel and make a list of the different weight with counterweights and worst case of moments/COG’s. After that, use a safety margin at for example 1.5 to decide maximum distance to COG for the tool, since there could be worse scenarios at other projects/XT’s.
    - The tool need to have the opportunity to be lifted in a level position when it is lifted alone.
- When we write design basis, we use a lot of explanations/information to explain and make the subject more clear for the examiner. It is important that we do not mix requirements and general explanations.
- We are allowed to convert the spool/H4 profile from Solidworks (Aker Soluions) and into Simenes NX (Out of the Aker Solutions system).

## Meeting no. 7 - Meeting with "Senior project engineer".

**Location:** Skype **Date:** 23.01.2019

**Purpose:** Get a better understanding of the different lifting scenarios.

The following list covers important notes and comments that was noted during the meeting.

- The TRT is mostly mounted on shore and they use a sling/rope to handle lifting off shore since no one will climb on top of the XT offshore.
- Most critical lift is from vessel to rig. Because of bad weather you should have a big distance between rig and boat when lifting. The rig is using its crane and lifts with a very long arm that results in a low lifting capacity. Maybe as low as 40 tonnes.
- There is different requirements when lifting offshore than on solid ground.
- There is safety factor on individual components like a shackle. Special requirements from vessel to rig, for example.
- DAF - Dynamic Amplification Factor - Can be low, medium and high factor. The higher the load is, the lower the DAF becomes.
- Standards she referred to:
    - NORSOK R-002 Annex c, d and f is most relevant, but also h and j. Requirement to material for shackles. Steel in general. The material selection can maybe be done by own selection.
    - NORSOK R-003 - Certification, not so relevant for us.
    - ISO 13628-4 - max tilt, maybe 1 degree? Possible it also says something about material selection.

## Meeting no. 8 - Status meeting with supervisor.

**Location:** Skype **Date:** 07.02.2019

**Purpose:** Discuss the process and the work done at this stage.

The following list covers important notes and comments that was noted during the meeting.

- Regarding the tilt angle, Sverre said we could do a simulation with a PGB and a XT to see how much tilt we could have before it collides, and use this angle as max tilt angle. This angle would be when the upper part of guide post are in touch with upper part of guide funnel, at the same time as the lower part of guidepost and funnel are in touch.
- Also do some research in the design basis and calculation reports of XT's and XTHT to see if there are mentioned something regarding the maximum allowed tilt angle of the XT.
- Don't have a temperature limitation exceeding 50 degrees celsius at the XTHT, because of difficult FEA simulation. He is going to find a document/source to this 50 degree limit.
- He will try to help us open Kamobo XT, as we have had problems with this. If he is not able to do this as well, we could look away from this and write following note: Because of problem opening the Kaombo XT in SW, the COG study for this XT will not be done. However the Kaombo XT is very similar to the Moho XT, an is a good indication of Kamobo's COG.
- The shackle itself need to have 5 in safety factor, the tool doesn't need that much.
- Check safety factor - Tool calculation report - Safety factor - Sverre will check with Ivars.
- We does not have to cancel a concept even though the tilt is to big. It can still be a good concept.
- We need to have a overview picture of the coordinate system of the XT that explains the COG movement and axis.
- TRT temp range may have to be bigger than -18c to 50c. Sverre will check this out.
- Vertical guide lines new designs - 35 pages. Sverre will send us a copy. The crane on the dock often is big since it should have the opportunity to lift a BOP. Weight limit here is no limitation for the tools.
- Max stress used offshore is 120ksi which is 827MPa. This is probably not a limiting factor for us. This is only for the TRT and not the XTHT.
- Check out the 4 degree angle locking mechanism. This can probably be used on TRT and maybe the XTHT. You can twist a wheel that leads a piston down. For a closer look at this, we can look at the connector at the bottom of the XT (cross section view). Between the piston and the locking pins.
- We need to look at if there are a shackle that is long enough for our use. We can check out Crossby shackles. Check SAP if we can find an "80 Crossby" or something.

- If we use a sliding mechanism with thread adjustment, a camera that films a level may be a solution. This can be livestream to a iPad or an other device. Or we can just measure the angle by hand, which is the solution that is used today.
- When it comes to the idea of reduce CW instead of complete removal, an idea is to have a lot of lifting holes in the cap, allowing more lifting possibilities and a better resolution.
- When it comes to the concept design review:
    - Book meeting approximately two weeks before.
    - Use powerpoint.
    - Also include result of our calculations we have done so far.
    - Not make it as detailed as Sverre's concept design review, which he sent us.
- Documents he sent us:
    - 10003522419 - Guideline for tools
    - 10002484774 - XTHT calculation report with safety factors.
    - 10001891941 - Product data sheet of WH connector.

## Meeting no. 9 - Meeting with "Specialist engineer".

**Location:** Skype **Date:** 09.02.2019

**Purpose:** Get guidance and information regarding the design basis

The following list covers important notes and comments that was noted during the meeting.

- Standards he referred to regarding lifting:
  - Norsok R002
  - NORSOK 273 - DAF 2.2
  - DNV 273 portable offshore alliance - overboard
  - ISO for tools ISO -Safety Factor 3 often used. He will send us
  - ISO 13628-4
- Dynamic application factor - DAF - Typically 1.33. Ivars will send example.
- Picked DAF from DNV 273 and the highest safety factor there.
- Recommends to use DNV 273 since this is the strictest.
- All standards point to each other.
- NORSOK says 2 times test load.
- DNV 273 test load 2.5 times - This is the strictest one. Using this will make the tool more universal.
- Typically total safety factor are close to 4.
- MGW - maximum gross weight= Lifted weight + tool weight.
- DNVGL-ST-0378 replaced DNV 2.22.
- Operation class R60 (applies for offshore) MGW $>$ 50 tonnes $\rightarrow$ DAF2.2
- Typical moonpool specifications:
  - Minimum 10m high.
  - 12m height from water surface to crane hook.
  - 4 meters minimum above tree.
  - Ivars will take a look at drawings of a moonpool.
- Crane capacities at a typical service vessel:
  - Small cranes: 100 tonnes to 200 tonnes.
  - Medium cranes: 200 tonnes.
  - Large cranes: 400 tonnes.
  - Moonpool cranes: 70 tonnes.
- Check out North sea giant (service vessel)

## Meeting no. 10 - Concept design review.

**Location:** Skype **Date:** 28.02.2019

**Purpose:** The purpose of this meeting was to perform a detailed and thorough review of our concepts, with intention to do a concept selection.

**Participant list:**

- Olsen, Sverre
- Grisans, Ivars
- Lundheim, Lars
- Snildal, Dag
- Kara, Suleyman
- Adzic, Goran
- Gulliksen, Caroline
- Nødset, Stian
- Ghanbari, Navid

All design review attendees actively participate by providing input or asking relevant questions during the review.

A lot of discussion regarding different issues were done through the meeting. The main and most important conclusion are listed below. For further comments that were noted, see the next list.

**Important conclusions:**

- During the presentation, a lot of different anti rotation concepts were presented and discussed. An anti rotation solution was initially needed since the operator can mount the tool in a "worst case angle" and the risk of the cap to rotate on the H4 profile is big. The following conclusion and comments were stated on the meeting:

  1. Due the extra challenges and complexities an anti-rotation solution would give, the students is allowed exclude this objective from their bachelor thesis. The basis for this decision is as follows:

     - The complexities of the tools will result in more risk and failure modes.
     - If there is only one lift configuration, "Complete XT", it is possible to make a foolproof concept when it comes to mount the tool in the correct angle. Lifting a complete XT with FCM and SCM is the most common lift, especially installing and retrieving subsea were this is the only relevant configuration. Anyhow, the goal of this bachelor thesis is to remove counterweights, which one configuration would still satisfy.
     - The final design would also be more likely to be realized if the anti-rotation issue isn't taken into account.

     Due to this exclusion and the the large risk if the tool is mounted in the wrong

angle, the XTHT and TRT should be designed to perform lifting of a completed stacked XT. In other words, the tools should be able to lift horizontally due the removal of counterweights at the XT, not due to the removal of FCM and SCM. Because of this, lifting the XT from vessel to rig without FCM and in a level position would not be possible.

2. When it comes to anti-rotation, it was also mention that it can't be used added friction due to varying friction coefficient. If the surface is dry, wet or has some grease on it, it needs to be taken into account. The normal force would have to be enormous when the support surface is greased.

- The concepts for lifting the XT in a level position was discussed, were there was agreement around the concepts, both at pros and cons. The most preferred and prioritized concepts were also shown, with good response from Aker Solutions, were the following conclusion was stated:

    1. There were several potential concepts, and the students are free to decide the concept.
    2. Due to the exclusion of the anti-rotation issue, the students could extend their concept phase with one week, trying to find new solutions with this new case.

**Other notes**

- As described in our design basis and the presentation, we had an requirement that a service vessel should have an overhead travelling crane if an off-center solution would be the final solution. The following conclusion were stated on the meeting:
    - Most of the service vessel does not have an overhead travelling crane in the moonpool. However, this wouldn't be a problem at many service vessels since the maximum off-center lift would be at 0.5m. In most moonpools, there would be enough space for such a displacement. Anyway, maybe there should be a arrangement at the TRT for the cursor system.
- During installation or retrieving of XT subsea, a work over system could be used. Since the CW is removed from the XT, there could be an issue if the different in mass between WOS and XT is too small and the XT mass would affect the COG. The students would not look into this, but it is important to mention in the final report. Aker Solutions will do studies regarding this issue.
- Keep in mind how to change the position at the TRT subsea. ROV interface.
- Keep in mind that under the roof there is often leak detectors. If there are a drilled hole in the roof there need to be an arrangement or system to prevent the oil or gas to leak out the hole, if not it could cause the detector to not record the leakage.

**Concept review comments**

1. Concept no. 1 - Secondary lifting point
    - N/A
2. Concept no. 2 - - Shark fin
    - Need long shackle or extender
    - Typical shackle hole diameter is 70mm.
3. Concept no. 2.5 - Holes in a shark fin alternatives

- Flap needs to be adjusted with crane

4. Concept no. 3 - Moving counterweights from tree to tool
   - When tool lifting only, a second lifting point is needed. It needs to be adjustable.
5. Concept no. 4 - Buoyancy - TRT only
   - Needs to withstand high pressure
6. Concept no. 5 - Slide with screw adjustment
   - The shackle do not need to be moved to a new hole when installing/retrieving the XT. A ROV can be used to screw the shackle to a new position.
   - Could be difficult to machine the interface between the yellow and the grey part.
   - Replace threaded rod with wire is a possibility.
7. Concept no. 6 - Slightly off center
   - They liked this solution. It is interesting for Aker, but if we want to solve the bachelor thesis, this is not a good concept.
8. Concept no. 7 - Rotating wheel
   - It needs to be shaved on the left side to make room for the shackle.
   - Hard to adjust pin when subsea.
9. Concept no. 8 - Sliding beam in house
   - Hard to adjust subsea/always
10. Concept no. 9 - Automatic adjustment - Tension measurement.
    - Electricity subsea is not something that they are happy about and they want to avoid that. Electronic devices is expensive as well.
    - Could be a great solution for the XTHT and not TRT.
    - ROV can be used to adjust the tool while subsea.
11. Concept 10 - Automatic adjustment - Hydraulic cylinder
    - When the cylinder is extended to the desired position, an additional/secondary mechanical lock needs to be used since the hydraulics can leak/fail.
    - Rov interface needs to be taken into account when using this subsea.
    - Bottom of the cylinder should be used for tool lifting only.
    - May need two cylinders instead of one. Replace the rod with a cylinder?

## Meeting no. 11 - Meeting with supervisor.

**Location:** Skype **Date:** 01.03.2019

**Purpose:** Discuss the concept design review.

**Main discussion**

Our conclusion from concept design review was that lifts without FCM and SCM will be neglected. The only possible and interesting lift is a fully equipped XT with FCM and SCM mounted. This was due to the possibility to mount the tool in an awkward angle that would result in a high rotational force. The rotational force would be so big that it can't be handled in a good way.

However, after this meeting with Sverre, the conclusion from the concept design review is changed. There may be another solution to this problem. If we want to design a tool that could do all four lifting configurations (with or without FCM,SCM, etc.), we are free to do that. In the future there would not be any problem for them to remove the three configurations and only have one, if they change their mind.

**Sverre clarified:** To this date, the only lift done subsea is with a complete XT. That's why there isn't such a big deal to not have just one lifting configuration instead of four. The goal of removing counterweights is then reached. On the other hand, if a new tool is made that has the opportunity to do all kinds of lifts subsea, this would open a whole new arena.

A solution to this problem can be to have all roof holes in different radius. Check with Lars on this one. Or maybe seal the holes that isn't being used when lifting subsea?

**Other notes**

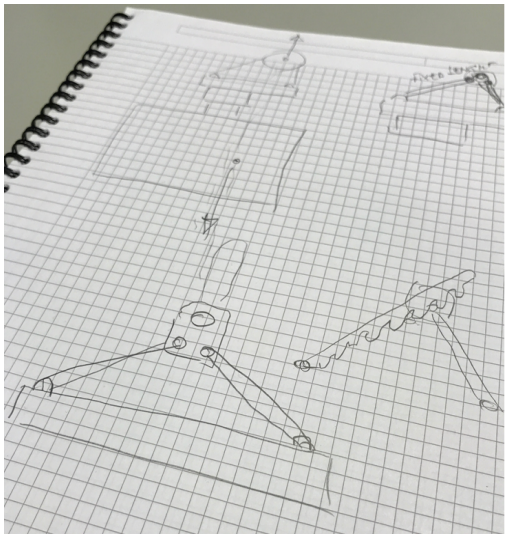
- Reinforcing the roof to handle rotational forces is not an option.
- Sverre wanted us to make a prototype with a 3D printer. That is not our first priority.

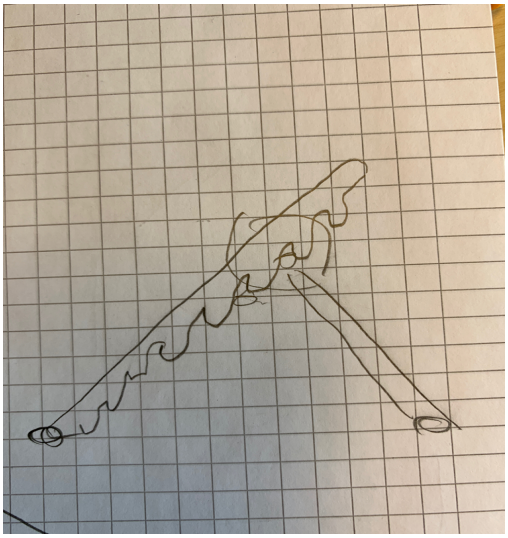
## Meeting no. 12 - Meeting with "Specialist engineer".

**Location:** Skype **Date:** 01.03.2019

**Purpose:** Discuss his concepts drawings.

**His drawings:**





We discussed the concept to the right most, which looks like saw teeth. This is based on the concept 10 in the concept design review, the hydraulic cylinder. Instead of the hydraulic cylinder, there could be mechanical “saw” that posisionate the crane hook which is hooked to a arrangement at the shortest rod. Instead of the saw, we also discussed to replace it with a threaded rod. Cons with both these, is that you take away the stepless solution that the cylinder gives, and you probably need to adjust the position with a crane.

He also mentioned that the car jack at the picture above could have some potential inspiration.

**Other notes**

- He recommended us to make a 3D print prototype of our solution, if we have time for that.
- ROV panel at concept 10 for hydraulic interface, the hydraulic cylinder.
- They had used an hydraulic piston at 120mm at another system with similar load condition.

## Meeting no. 13 - Secondary concept design review.

**Location:** Skype **Date:** 12.03.2019

**Purpose:** Perform a detailed and thorough review of our chosen concept, as well to show the other most relevant concepts.

**Participant list:**

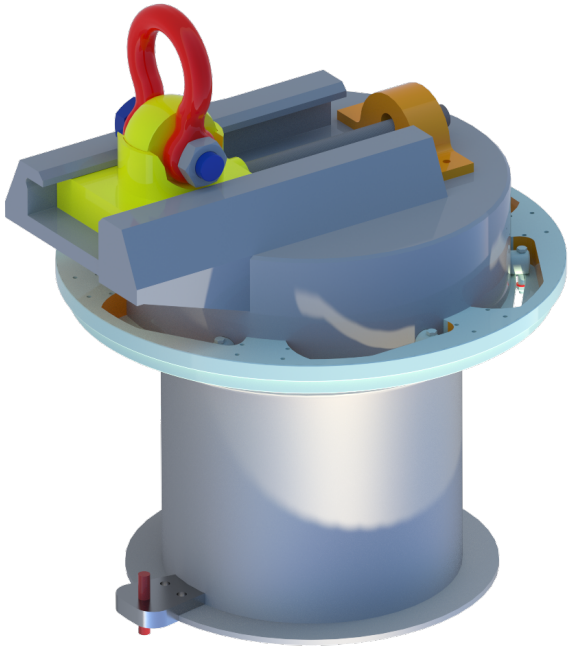
- Olsen, Sverre
- Grisans, Ivars
- Lundheim, Lars
- Gulliksen, Caroline
- Nødset, Stian

The following where covered and discussed during the meeting:

- Concept to reduce risk of angle misalignment
- The most relevant concepts for level lifting
- Our chosen concept for level lifting

**Main discussion**

The most discussed topic was our chosen concept for level lifting, which is shown in the figure below.



The following comments were noted:

- We need to consider snagging points for the wire at the beam.
- A TRT concept could be based on the XTHT concept. Regarding this, the following were noted:
    - The ROV has a torque tool that can connect to an ROV bucket and then turn the screw.
    - The ROV panel needs to be on top of the tool. This in the only place the ROV could be guaranteed access in all scenarios, is above the XT and at the ROV panel at the XT. If the tool are mounted for example 180 degrees from the XT the ROV panel, the space could be tight if the XT for example are placed at a manifold.

**Other notes**

- A new and very relevant issue was presented during the meeting. As the FCM is a retrievable unit at the XT, this could sometimes be changed into a new FCM. This FCM could be lighter or heavier compared to its predecessor. This would change the XT COG position as the new FCM are installed. Other modification could also be done at the XT, which also will result in a relocation of the COG. This means that the drilled holes in the roof no longer match the COG position. Therefore, we need to do a "maximum angle misalignment" study to set the limitation for how great the relocation of COG could be, before the lift becomes dangerous.
- Anti-rotation
    - We need to state it clear in the report that anti-rotation is an important issue offshore and need to be looked more into by Aker Solutions, after the bachelor thesis is completed. This is important offshore due to relative motions and forces generated to the XT because of waves. Especially in splashzone, were the COG and gravitational force at the XT could change dramastically and thereby is an anti-rotation device crucial. The gravitational force of the XT can even become negative in some cases.
    - At new XT, the MVB could be modified to interface a possible anti-rotation contrivance. At existing XT, this is not desirable.
- Threaded rod
    - The clamp-connector used to connect the FCM to the manifold hub, has a thread rod. Based on our hand calculations so far, this rod has the same size as we need. There have been done a lot of calculations for this threaded rod, so Aker Solutions recommends that we use this as a base, to save us some time.
- A good contact person when it comes to friction is Ravi Abbigeri
- Have a clear overview of the difference consequences that could occur if the tool is mounted the wrong way.

## Meeting no. 14 - Meeting with supervisor.

**Location:** Skype **Date:** 13.03.2019

**Purpose:** Discuss the secondary concept design review.

The following list covers important notes and comments that was noted during the meeting.

- Threaded rod to chosen concept
    - Use 355 structure steel
    - Aker are very familiar with grease on threaded rods, both onshore and subsea.
    - Use the threaded rod at the clamp connector as basis. If possible, just use the same screw and specs, to save time at for example calculations and design.
- Aker Solutions approach when it comes to detailed designing:
    1. Design the tool. Gather the whole assembly.
    2. Run FEA analysis with unlimited force. See when the tools break and locate the weak link
    3. Modify the design
    4. Repeat
- We need to do a “maximum angle misalignment” study. We could also do some tests in Solidworks, by for example add weight to the XT assembly and see how much the COG moves. See meeting no. 13 for further details regarding this study.
- Tool position verification at the roof
    - Look into the possibility of having different shape or/and size at the holes in the roof, instead of different radiuses.
    - If many radiuses makes the tool complicated, we can use one radius.

## Meeting no. 15 - Meeting with "Global riser analysis engineer".

**Location:** Skype **Date:** 29.03.2019

**Purpose:** Get some tips and assistance inFEA and methodology at Aker Solutions.

The following list covers some question we prepared and important comments that were noted during the meeting.

- **Do you do a mesh convergence study?**
  As he have a lot of experience he go by his feelings, but sometimes he does it if he is insecure. We should maybe do a convergence study in the lifting lug radius.
- **Best notch-factor when it comes to design?**
  The notch depends more on what is possible to do in manufacturing and what notch the manufacturing tools will create.
- Can often look away from local plastic deformations
- Can do a lot of hand calculations
- No problem with small singularities (high stress concentration at for example one element)
- Can use earlier lifting dog and spool calculations regarding capacity instead of doing the contact FEA at this interface.
- Maximum shear stress is 57% of yield strength (yield strength/$\sqrt{3}$).
- Check out different materials and properties
- Study the COG of the final design, and is there a risk of tipping?

## Meeting no. 16 - Status meeting with supervisor.

**Location:** Skype **Date:** 29.03.2019

**Purpose:** Discuss the process and the work done at this stage.

The following list covers important notes and comments that was noted during the meeting.

- Example on hipped components by Sandvik:
  - 10231696 - Forging TH Orientation Pin
  - 10248288 - Main Body THOP
  - 10245527 - THOP assy
- We would have coating to coating interface between dogs and H4, check friction factor.
- In the final design review and report, show a weight comparison of today's tool and the new designed.
- When it comes to capacities to anti-rotation pin and the roof, the pin should be designed to be the weak link in the connection, not the roof.
- In the report, write a short chapter regarding material selection and manufacturing options. It just a short text because this is not a part of our thesis, but we want to come with recommendations and show that we have thought of the manufacturing phase during the design.
- At the screw to operator interface. Use HEX head at the screw, not umbraco and have a replaceable adapter in case the HEX gets destroyed.

## Meeting no. 17 - Status meeting with supervisor.

**Location:** Skype **Date:** 15.04.2019

**Purpose:** Discuss the process and the work done at this stage.

The following list covers important notes and comments that was noted during the meeting.

- Create a meeting with Per-Christian Braaten. Discuss the difficulties of machining the main body and latch ring.
- When it comes to displacement requirement in FEA, it is hard to settle a value. It depends on the situation. It would probably be good enough as long as the tension is within elastic deformation and plastic deformation does not occur. However, this needs to be discussed at each component analyzed.
- ROV interface: ISO 13628-8. To ensure proper interface is low priority. To ensure proper placement and access of ROV interface are good enough. Optimization and changing dimensions on the interface are further work for Aker Solution.
- Useful material numbers:
    - 10216778 - Latch ring handle. Inspiration. Possibility to reuse? Drawing no.:10002493312
    - 10229686 - Locking dog. Check DIR 10002471229 for drawing. Use as inspiration when making drawing of our locking dogs. Check out note no. 4 regarding manufacturing a ring and cut it into desired number of dogs.
- Material to funnel: S355 or S450
- Regarding tipping of the tool as it stands on the ground:
    - **Source requirement:**
      “Best practice is to have COG below 30 degrees, sourced from Application Engineering, Product support department."

# Mails

This section covers important mail correspondence which were necessary to attach to the report. The mails are presented at the following pages.

# Mail no.1 - Machining possibilities

Hei,

Ut ifra det jeg ser her bør det være mulig å maskinere.

Jeg antar da at lommene innvendig i den gule delen er støpt og ikke trenger maskinering. Sporene går greit å maskinere.

Best regards,
**Per-Christian Braaten**
Process Leader | Machining and Welding
Tranby
**Aker Solutions**

Tel: +47 32 85 90 07 Mob: +47 907 39 875
per-christian.braaten@akersolutions.com | www.akersolutions.com

Aker Subsea AS
Visiting address: Joseph Kellers Vei 20, Tranby, NO-3401 Lier, Norway
Postal address: PO Box 73, NO-3401 Lier, Norway
Registered in Norway, registration no. 929 877 950 VAT

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**From:** Nesje, Jørgen
**Sent:** 23. april 2019 10:34
**To:** Braaten, Per-Christian <per-christian.braaten@akersolutions.com>
**Cc:** Olsen, Sverre <Sverre.Olsen@akersolutions.com>
**Subject:** Maskineringsmuligheter

Hei Per-Christian,

Vi er to studenter som skriver en bacheloroppgave der vi skal videreutvikle Xmas Tree Handling Tool (XTHT).

I den forbindelse har vi et par design som vi er usikre på når det kommer til maskinering. Vårt spørsmål er i bunn og grunn om det er mulig å maskinere.

Det er to komponenter dette gjelder, main body (grå) og latch ring (gul). Sjå vedlegg for bilder og grov dimensjon av komponentene. Tanken er at komponentene skal støpes og maskineres ut i fra et grovgods.

Håper du raskt kan svare på dette, da det er kun to uker til designet må være satt. Vi kan gjerne få til et Skype møte vist det er enklere.

Best regards,
**Jørgen Nesje and Fredrik Øveråsen**
Bachelor students | NTNU Ålesund

Tel: (+47) 46808139 and (+47) 90698725
jorgen.nesje@akersolutions.com

# Mail no.2 - Main body, Hipping possibility, Sandvik

-----Original Message-----
From: Roald Fosse <roald@sverdrupsteel.com>
Sent: den 20 mars 2019 18:52
To: Jimmy Bovin <jimmy.bovin@sandvik.com>
Subject: FW: Internet enquiries: Enquiry from Jørgen Nesje (Aker Solutions)

Sett denne her?

-----Original Message-----
From: Information Systems [mailto:information_systems@sandvik.com] On Behalf Of noreply
Sent: 20. mars 2019 15:52
To: Roald Fosse <roald@sverdrupsteel.com>
Subject: Internet enquiries: Enquiry from Jørgen Nesje (Aker Solutions)

From: Jørgen Nesje
Company: Aker Solutions
Email: jorgen.nesje@akersolutions.com
Phone: 47 46 80 81 39
E-mail/phone:
Country: Norway
Topic: Hot isostatic pressed (HIP) products

Hi,

We are two students doing a bachelor thesis in cooperation with Aker Solutions, at NTNU Aalesund. We are now looking into manufacturing possibilities at one of our component and find your HIP method interesting.
Therefore, we wonder if you could have looked at the following:

Is the component possible to HIP?

Approximately price?

The component is attached as a step file of the 3D model.

Best regards, Jørgen Nesje and Fredrik Øveråsen

**From:** Nesje, Jørgen <Jorgen.Nesje@akersolutions.com>
**Sent:** den 21 mars 2019 09:50
**To:** Jimmy Bovin <jimmy.bovin@sandvik.com>
**Cc:** Roald Fosse <roald@sverdrupsteel.com>
**Subject:** RE: Internet enquiries: Enquiry from Jørgen Nesje (Aker Solutions)

Hi Jimmy,

No problem, see the attached file.

If you still experience problem, are there any other potential file formats?

Best regards,
**Jørgen Nesje and Fredrik Øveråsen**
Bachelor students | NTNU Ålesund

Tel: (+47) 46808139 and (+47) 90698725
jorgen.nesje@akersolutions.com

**From:** Jimmy Bovin <jimmy.bovin@sandvik.com>
**Sent:** torsdag 21. mars 2019 09:44
**To:** Nesje, Jørgen <Jorgen.Nesje@akersolutions.com>
**Cc:** Roald Fosse <roald@sverdrupsteel.com>
**Subject:** RE: Internet enquiries: Enquiry from Jørgen Nesje (Aker Solutions)

Jørgen,

Have some issues to access the .STEP file could you forward it by email to you and we will have a look? 😊

Looking forward to hear from you!

**Jimmy BOVIN**
Application Development Manager

Sandvik Powder Solutions AB
Office: +46 220 221 09
Mobile: +46 73 060 66 10
Mailto:jimmy.bovin@sandvik.com
www.smt.sandvik.com

Follow us:

Hi Jimmy,

Wonderful!

The material we are planning to use is as follows: TTSTE 355 Z3

We are in an early phase of the product development, and note that this could change. Other options are standard structural steel or alloy steel as AISI 8630.

Quantities is hard to say now. But typically, a couple of this is needed as each project to be signed by Aker Solutions.

Best regards,
**Jørgen Nesje and Fredrik Øveråsen**
Bachelor students | NTNU Ålesund

Tel: (+47) 46808139 and (+47) 90698725
jorgen.nesje@akersolutions.com

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**From:** Jimmy Bovin <jimmy.bovin@sandvik.com>
**Sent:** torsdag 21. mars 2019 16:00
**To:** Nesje, Jørgen <Jorgen.Nesje@akersolutions.com>
**Cc:** Roald Fosse <roald@sverdrupsteel.com>
**Subject:** RE: Internet enquiries: Enquiry from Jørgen Nesje (Aker Solutions)

Jørgen,

Now it worked thank you!

Could I ask what material you want to use and what material requirements do you have? 😊

And it would also be interesting to understand the quantities if you have an idea about them-

Looking forward to hear from you!

**Jimmy BOVIN**
Application Development Manager

Sandvik Powder Solutions AB
Office: +46 220 221 09
Mobile: +46 73 060 66 10
Mailto:jimmy.bovin@sandvik.com
www.smt.sandvik.com

Jörgen,

First of all I'm extremely sorry for my extreme late response. It have been an extremely hectic period.

Looking at the shape and the materials you are thinking to use I don't think that HIPing this piece will be cost effective.
HIPing a high carbon steel part will be much more expensive than producing it the conventional way.

Hence HIP is often used in applications with high demands in terms of material properties(corrosion, strength, HISC resistance etc.) and typical materials is nickel alloys, Duplex / Super Duplex Stainless steel or other exotic alloys.
Often complex shapes where removing welds have a huge cost/risk reduction benefit.

Looking at your part it looks like the welds would be quite straight forward and as you have planned to use construction steel I don't think a HIP:ed stainless steel or nickel allow would add any benefit as you are not after better corrosion resistance, isotropic material properties etc.

I think a good example of a components which is ideal for HIP is a manifold; you have a long design life (25+ years), it's a critical application where material properties is essential, its complex and have a lot of welds. The below section is an example where its HIP:ed as one piece and only machined on flanges and welds necks. Removing welds and machining make HIPing it the most cost effective way while also getting the additional benefits with better HISC resistance etc.

Hope it helps you. And if its any questions or anything else we can help you with just give me a shout!

**Jimmy BOVIN**
Application Development Manager

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